

COMMITTEE ON SCIENCE  
SUBCOMMITTEE ON ENVIRONMENT, TECHNOLOGY, AND STANDARDS  
U.S. HOUSE OF REPRESENTATIVES

**HEARING CHARTER**

***What is Space Weather and Who Should Forecast It?***

October 30, 2003, 2003

10:00 a.m. to 12:00 p.m.

2318 Rayburn House Office Building

**Purpose:**

On October 30, 2003 at 10:00 a.m., the House Science Committee's Subcommittee on Environment, Technology and Standards will hold a hearing to examine the space weather activities at the National Oceanic and Atmospheric Administration's (NOAA) Space Environment Center. The Space Environment Center (SEC) provides real-time monitoring and forecasting of solar and geophysical events. These events can: cause damage to communication satellites, electric transmission lines and electric transformers; interfere in ground-based communications with airline pilots; be fatal to astronauts on space flights and in the International Space Station; and potentially harm airplane passengers flying polar routes. SEC forecasts are used by the U.S. military, the National Aeronautics and Space Administration (NASA), NOAA itself, and by the industries mentioned above. For example, just last Wednesday (October 22), the SEC released two-day advanced warnings about an unusually large solar storm, which allowed electrical utilities, airlines, and spacecraft managers to take preventive action to minimize disruption of service due to the storm. (See attachment.)

The Air Force Weather Agency works closely with NOAA's SEC on the collection of space weather data through satellite and ground-based sensors and provides warnings tailored for specific military needs. The Air Force relies on the SEC for data analysis and overall forecasting. The Air Force and NOAA each contribute to the cost of sensors to monitor space weather, and NASA provides many of the satellites on which the sensors are carried.

In the House Fiscal Year (FY) 2004 Commerce, Justice and State (CJS) appropriations bill, SEC funding levels are below the Administration's request. The Senate CJS Appropriations Committee report includes the suggestion that the Air Force or NASA should take on the duties of predicting space weather and contains no funding for SEC. Thus, budget constraints could force the closure or reduction of these vital and unique services provided by NOAA's SEC. The Subcommittee wants to better understand the potential impact of the loss of SEC services.

The Subcommittee plans to explore several overarching questions, including:

1. Why do we need to understand and forecast space weather events?
2. What unique capabilities and expertise does NOAA's SEC provide? To what extent could the Air Force or NASA perform these duties?
3. What are the implications of closure or reduced activities of NOAA's SEC to the government and private sector?

### **Witnesses:**

**Dr. Ernest Hildner**, Director, Space Environment Center, National Oceanic and Atmospheric Administration (NOAA), Boulder, Colorado. Dr. Hildner will provide an overview of the SEC, the services it provides and its collaborations with other Federal agencies.

**Col. Charles L. Benson Jr.**, Commander, Air Force Weather Agency, Offutt Air Force Base, Nebraska. Colonel Benson will explain the mission of Air Force Space Weather Operations Center and the way the Air Force and NOAA work together on space weather prediction.

**Dr. John M. Grunsfeld**, Chief Scientist, National Aeronautics and Space Administration (NASA). Dr. Grunsfeld will discuss the effects of space weather on NASA operations.

**Mr. John Kappenman**, Manager, Applied Power Systems, Metatech Corporation, Duluth, Minnesota. Mr. Kappenman will discuss the effects of space weather events on electric power grid systems and how the loss of NOAA's SEC would affect this industry. Mr. Kappenman was formerly with Minnesota Power.

**Mr. Hank Krakowski**, Vice President of Corporate Safety, Quality Assurance, and Security, United Airlines, Chicago, Illinois. Mr. Krakowski will discuss how space weather events affect the airline industry, including air traffic control communications and human health concerns. He also will discuss how the loss of NOAA's SEC would affect United Airlines operations.

**Dr. Robert Hedinger**, Executive Vice President, Loral Skynet, Bedminster, New Jersey. Dr. Hedinger will explain the implications of space weather events for communications satellites and how the loss of NOAA's SEC would affect the commercial satellite sector.

### **Background**

#### **What is space weather?**

Space weather refers to conditions on the sun and in the solar wind, which can cause disturbances in the outer layers of the Earth's atmosphere. Highly energized particles from the sun disrupt the upper layers of the Earth's atmosphere, causing geomagnetic storms that result in increased radiation and rapid changes in the direction and intensity of the Earth's magnetic field. These conditions can influence the performance and reliability of space-borne and ground-based technological systems and can endanger human life or health. Government and private sector organizations concerned with communications, satellite operations, electric power grids, human space flight, and navigation use space weather information.

#### **History of NOAA's Space Environment Center**

NOAA's Space Environment Center (SEC), located in Boulder, Colorado, began in the 1940's as a program to study short-wave radio propagation at the National Bureau of Standards (now known as the National Institute of Standards and Technology, or NIST). As the SEC expanded its scope to study the effects of solar weather on the Earth's atmosphere, the center moved into the Office of Oceanic and Atmospheric Research in NOAA, where it is currently located. The SEC consists of three divisions: research and development, space weather operations, and systems. The SEC has 54 NOAA staff and two Air Force liaisons in its Boulder office. In a 2002 report, the National Academy Sciences, called the work of the SEC "crucial."

NOAA's SEC collects, provides, and archives space environment data from its polar-orbiting and geostationary satellites, from other Federal agencies, and through international data exchange. Forecasters at SEC provides space weather forecasts and warnings to users in

government and industry and to the general public, while the Air Force and private sector users take these forecasts and tailor them for their organizations' specific needs. SEC's space weather operations division is the national and international warning center for disturbances in the space environment that can affect people and equipment. The effects of these disturbances are described in more detail below. The research and development division is home to the leading experts in space weather. They conduct research in solar-terrestrial physics, develop techniques for forecasting solar and geophysical disturbances, provide real-time monitoring and forecasting of solar and geophysical events, and prepare data to be archived by NOAA's National Geophysical Data Center.

#### **Air Force Space Forecast Center**

NOAA's SEC works closely with the U.S. Air Force's Space Forecast Center at Offutt Air Force Base in Nebraska, which provides space weather forecast services to U. S. military customers. The total budget for Air Force space weather efforts was \$15.3 million in FY2003. The Air Force provides two personnel who work at the SEC to ensure that this vital space weather information is fed smoothly to the Air Force, which then tailors it for military purposes. For example, NOAA's SEC may issue a warning that a geomagnetic storm will occur in the Earth's atmosphere at a certain time. The Air Force will use this information to make recommendations about military satellites that should be turned or powered down, or military operations that should be suspended until the storm passes.

#### **NASA Operations**

NASA requires information about space weather to make decisions regarding the space shuttle and International Space Station (ISS) operations. For example, astronauts conducting space walks could be killed if they were exposed to high levels of radiation. Additionally, astronauts inside the ISS may have to take special precautions during a solar storm. In fulfilling its research mission, NASA flies many of the sensors used to collect space weather data on its research satellites.

#### **National Space Weather Program (NSWP)**

Previous reviews of the space weather program have concluded that NOAA should continue to run the civilian space weather forecasting operation.

For example, in 1997, an interagency working group developed "The National Space Weather Program Implementation Plan," under which NOAA was to continue to run civilian space weather programs and the Air Force was to continue to run such programs for the military. The interagency group included NOAA, the National Science Foundation, the Department of Defense, NASA, the Department of Energy, the Department of the Interior, and the Department of Transportation.

Similarly, in its 2002 report, "The Sun to the Earth – and Beyond: A Decadal Research Strategy in Solar and Space Physics," the National Academy of Sciences recommended that NOAA not only continue to forecast space weather but that NOAA should do more to coordinate the development of the sensors that are used to make its forecasts. Specifically, the Academy recommended that NOAA and NASA initiate a plan to transition solar monitoring sensors from their current location primarily on research satellites to operational satellite programs.

### **The SEC budget situation**

The Space Environment Center is funded through NOAA's Office of Oceanic and Atmospheric Research (OAR). In FY2003, the SEC received \$5.2 million (a reduction of \$2 million below FY2002 levels). For FY2004, the Administration requested \$8 million for NOAA's SEC. At this time, the FY2004 appropriations process is ongoing in Congress. The House Commerce, Justice, State (CJS) bill, passed in July, provides \$5.2 million for the SEC (same level as FY2003). The Senate CJS bill, reported out by the full committee, recommends no funding for SEC and suggests that the Air Force or NASA should assume the responsibility of forecasting space weather. Funding for some of the sensors and satellites that provide data to the SEC is already provided by other agencies, such as NASA and the Air Force, but NOAA's SEC is the national center for data collection and forecasting of space weather events.

<b>SEC Funding History 2002-Present</b> (in millions of dollars)					
FY2002 Enacted	FY2003 Request	FY2003 Enacted	FY2004 Request	FY2004 House bill	FY2004 Senate Committee Recommendation
\$7.24	\$7.78	\$5.24	\$8.02	\$5.29	\$0

### **Why do we need space-weather forecasts from NOAA's SEC?**

#### **Electric Power Grids**

The first recorded evidence of space weather effects on technology was in 1859, when a major failure of telegraph systems in New England and Europe coincided with a large solar flare. More recently, on March 13, 1989, geomagnetically induced currents in Canadian transmission lines set off a cascade of broken circuits, causing loss of power for the entire Hydro-Quebec power grid. The blackout affected six million customers and cost Hydro-Quebec more than \$10 million.

In 1998, a similar geomagnetic storm was headed for Earth. This time, thanks to data from new sensors and improved forecast models, NOAA's SEC forecasters were able to alert electric power customers 40 minutes before the storm hit the Earth. In response, electric power utilities diverted power and increased safety margins on certain parts of the grid to avoid stress on the power system.

#### **Satellite Operations**

In addition to electric power grid operations, human activities dependent on satellites are affected by space weather. This includes everything from communications to satellite-television. Research done at NOAA's SEC has helped provide the government and other satellite operators with data on storms to help understand whether a failed satellite was due to mechanical problems or space weather. Additionally, the satellite industry uses space weather forecasts to determine the timing of rocket launches to avoid sending a multi-million dollar satellite into orbit at the peak of a solar storm.

#### **Communications Satellites**

Solar storms cause disturbances in the Earth's ionosphere that can affect the orbital path of low-orbit spacecraft, creating operational and tracking problems and sometimes shortening the useful life of a satellite. For example, in May 1998 loss of telephone pager service to 45 million customers was caused by a solar storm. During the Gulf War in 1991 military forces reported

high frequency radio communications interruptions due to ionization storms, and in January 1994 an extended period of high electron levels caused failure of two Canadian communications satellites, which interrupted telephone, television, and radio service for several hours.

### Airline Industry

Airlines are concerned about space weather because it can disrupt satellite and ground-based communication systems, which allow air traffic controllers to talk directly to pilots. Federal regulations require airlines to maintain communication capability with their aircraft at all times. Additionally, navigation systems can be affected by space weather events. Finally, because of the curvature of the Earth, planes flying from North America to Asia generally make flights over the North Pole, where passengers can be susceptible to higher doses of solar radiation than traditional non-polar flights. United Airlines reports that for the 21-month period from January 2002 through September 2003 there were approximately 140 flights that were or could have been affected by space weather events.

### Questions for Witnesses

Dr. Ernest Hildner, Director, Space Environment Center, National Oceanic and Atmospheric Administration (NOAA)

1. Please provide an overview of NOAA's Space Environment Center (SEC). What research programs are performed at the center? What operational services are provided by the center?
2. Please describe the different types of solar weather events and specifically explain the time it takes for them to travel to the Earth. What is the lead-time we currently have for reacting to or mitigating the effects of solar weather? Please provide historical examples of when space weather events have affected human activities.
3. Who are the users of SEC products and information?
4. Please describe the relationship between the SEC, NASA, and the Air Force Weather Agency, including a specific explanation of the role of each agency in understanding and predicting space weather.
5. If the FY04 final appropriation for the SEC was the \$5.2 million recommended in the House bill, what would be the impact on SEC services?

Col. Charles L. Benson Jr., Commander, Air Force Weather Agency

1. Please provide an overview of the Air Force Space Weather Services provided through the Air Force Weather Agency.
2. Please describe the relationship between NOAA's Space Environment Center (SEC), NASA, and the Air Force Weather Agency, including a specific explanation of the role of each agency in understanding and predicting space weather.
3. Who are the users of Air Force space weather products and information?
4. Are there any technical barriers to the Air Force Weather Agency taking on the duties of the SEC if it were no longer funded through NOAA? Given that the Air Force's capabilities are designed for military purposes, how would you have to adapt your practices to provide SEC-like services to the civilian sector?
5. What would be the impacts on the Air Force and overall military operations if SEC no longer existed? Please provide specific examples when possible.

Dr. John M. Grunsfeld, Chief Scientist, National Aeronautics and Space Administration (NASA).

1. Please provide an overview of how space weather can affect NASA operations, including examples of historical events that have caused problems.
2. How does NASA use data and products from NOAA's Space Environment Center (SEC)? In general, how much lead time do you need to make decisions for mitigating the effects of space weather?
3. How would you compare our knowledge today of the impacts of space weather on NASA operations to what we knew five years ago, and to what we expect to know five years from now?
4. What would be the impact to NASA if SEC were no longer able to provide its space weather forecasts to you? Please provide specific examples when possible.
5. Are there any technical barriers to NASA taking on the duties of the SEC if it were no longer funded through NOAA? Given that NASA's mission is research oriented, how would you have to adapt your practices to provide SEC operational services?

Mr. John Kappenman, Manager, Applied Power Systems, Metatech Corporation

1. Please provide an overview of how space weather can affect electric power grid systems, including examples of historical events that have caused problems.
2. How does your organization use data and products from NOAA's Space Environment Center (SEC)? In general, how much lead time do you need to make decisions for mitigating the effects of space weather?
3. How would you compare our knowledge today of the impacts of space weather on electric power grid systems to what we knew five years ago, and to what we expect to know five years from now?
4. What would be the impact to your organization and the electric power grid industry if SEC were no longer able to provide its space weather forecasts to you? Please provide specific examples when possible.

Mr. Hank Krakowski, Vice President of Corporate Safety, Quality Assurance and Security, United Airlines

1. Please provide an overview of how space weather can affect airline operations, including examples of historical events that have caused problems.
2. How does your organization use data and products from NOAA's Space Environment Center (SEC)? In general, how much lead time do you need to make decisions for mitigating the effects of space weather?
3. How would you compare our knowledge today of the impacts of space weather on airline operations to what we knew five years ago, and to what we expect to know five years from now?
4. What would be the impact to your organization if SEC were no longer able to provide its space weather forecasts? Please provide specific examples when possible.

Dr. Robert Hedinger, Executive Vice President, Loral Skynet

1. Please provide an overview of how space weather can affect satellite operations, including examples of historical events that have caused problems.

2. How does your organization use data and products from NOAA's Space Environment Center (SEC)? In general, how much lead time do you need to make decisions for mitigating the effects of space weather?
3. How would you compare our knowledge today of the impacts of space weather on satellite operations to what we knew five years ago, and to what we expect to know five years from now?
4. What would be the impact to your organization if SEC were no longer able to provide its space weather forecasts? Please provide specific examples when possible.